IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant	:	Richard L. Coulson	
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Customer No.	:	008791	

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Declaration of Richard L. Coulson
Pursuant to 37 C.F.R. §1.131

Sir:

I, Richard L. Coulson, hereby declare that:

1. I am a citizen of the United States of America, and currently reside at 17454 N.W. Gilbert Lane, Portland, Oregon, 97229, USA.

2. I am currently an employee of Intel Corporation in Hillsboro, Oregon.

3. The subject invention was conceived at least as early December 27, 2000, as evident by the attached document dated December 27, 2000.

4. I was a joint author of the subject document.

5. I have reviewed the enclosed copy. It is a true copy of the document I authored.

6. Since conception, I diligently pursued the invention including working with other Intel engineers to render the invention into practice, as well as working

with attorneys of Marger, Johnson, et al. in preparing and filing the subject patent application.

7. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-identified patent application or any patent issued thereon.

Executed on: 10/8/04

At: Hillsboro, Oregon

By: _____

Richard L. Coulson

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INTEL INVENTION DISCLOSURE

ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

17706

JAN 1 6 2001

DATE: 12/27/00

Software / IAL / ISL

It is important to provide accurate and detailed information on this form. The information will be used to evaluate your invention for possible filing as a patent application. When completed and signed, please return this form to the **Legal Department at JF3-147.** If you have any questions, please call **264-0444.**

1. Inventor: Coulson (Last Name) Richard (First Name) L (Middle Initial)

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***Corporate Level Group (e.g. IABG, NCG, CEG) NBG Division IAL Subdivision ISL**

Supervisor* Sanjay Pandiji WWID _____ Phone _____ M/S: JF2-53

2. Title of Invention Mass Storage Caching Algorithms for Power Reduction

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JAN 2 2 2001

PATENT DATABASE GROUP
INTEL LEGAL TEAM

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PLEASE READ AND FOLLOW THE DIRECTIONS ON HOW TO WRITE A DESCRIPTION OF YOUR INVENTION

Please attach a description of the invention to this form, DATED AND SIGNED BY AT LEAST ONE PERSON WHO IS NOT A NAMED INVENTOR, and include the following information:

1. **Describe in detail what the components of the invention are and how the invention works.**
2. **Describe advantage(s) of your invention over what is done now.**
3. **YOU MUST include at least one figure illustrating the invention. If the invention relates to software, include a flowchart or pseudo-code representation of the algorithm.**
4. **Value of your invention to Intel (how will it be used?).**
5. **Explain how your invention is novel. If the technology itself is not new, explain what makes it different.**
6. **Identify the closest or most pertinent prior art that you are aware of.**
7. **Who is likely to want to use this invention or infringe the patent if one is obtained and how would infringement be detected?**

***HAVE YOUR SUPERVISOR READ, DATE AND SIGN COMPLETED FORM**

DATE: 11/9/04 SUPERVISOR: _____

BY THIS SIGNING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID

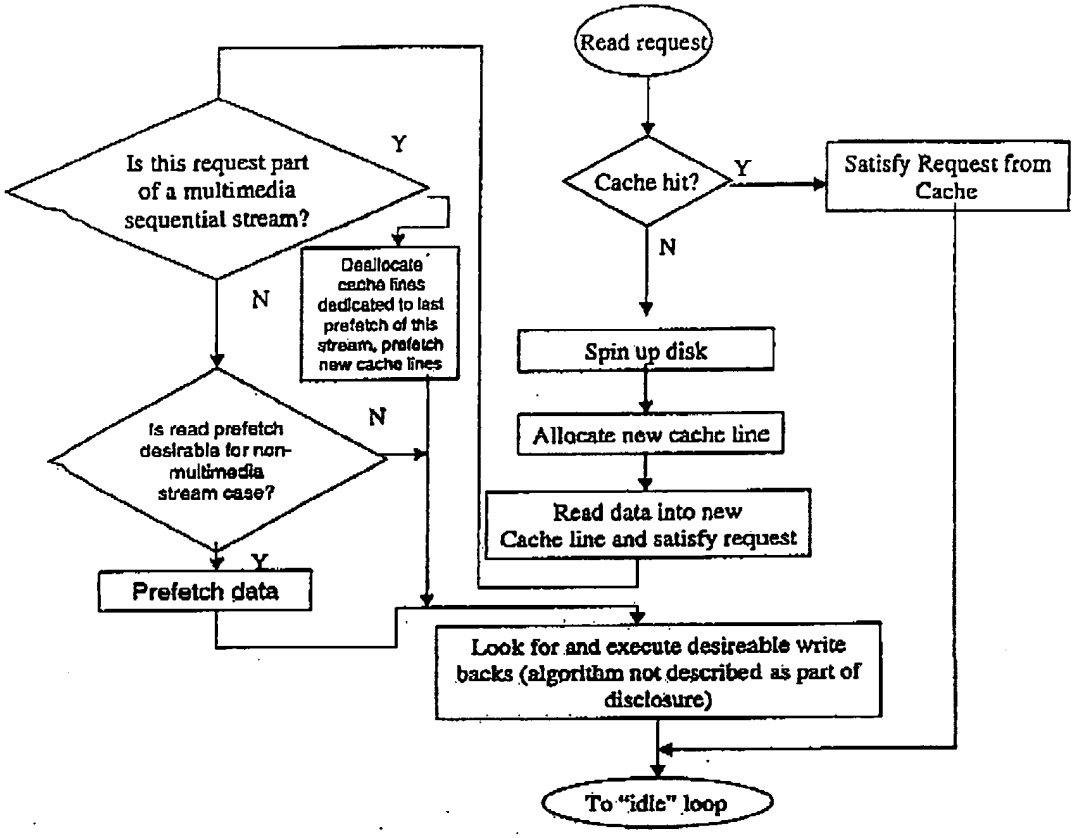
Background

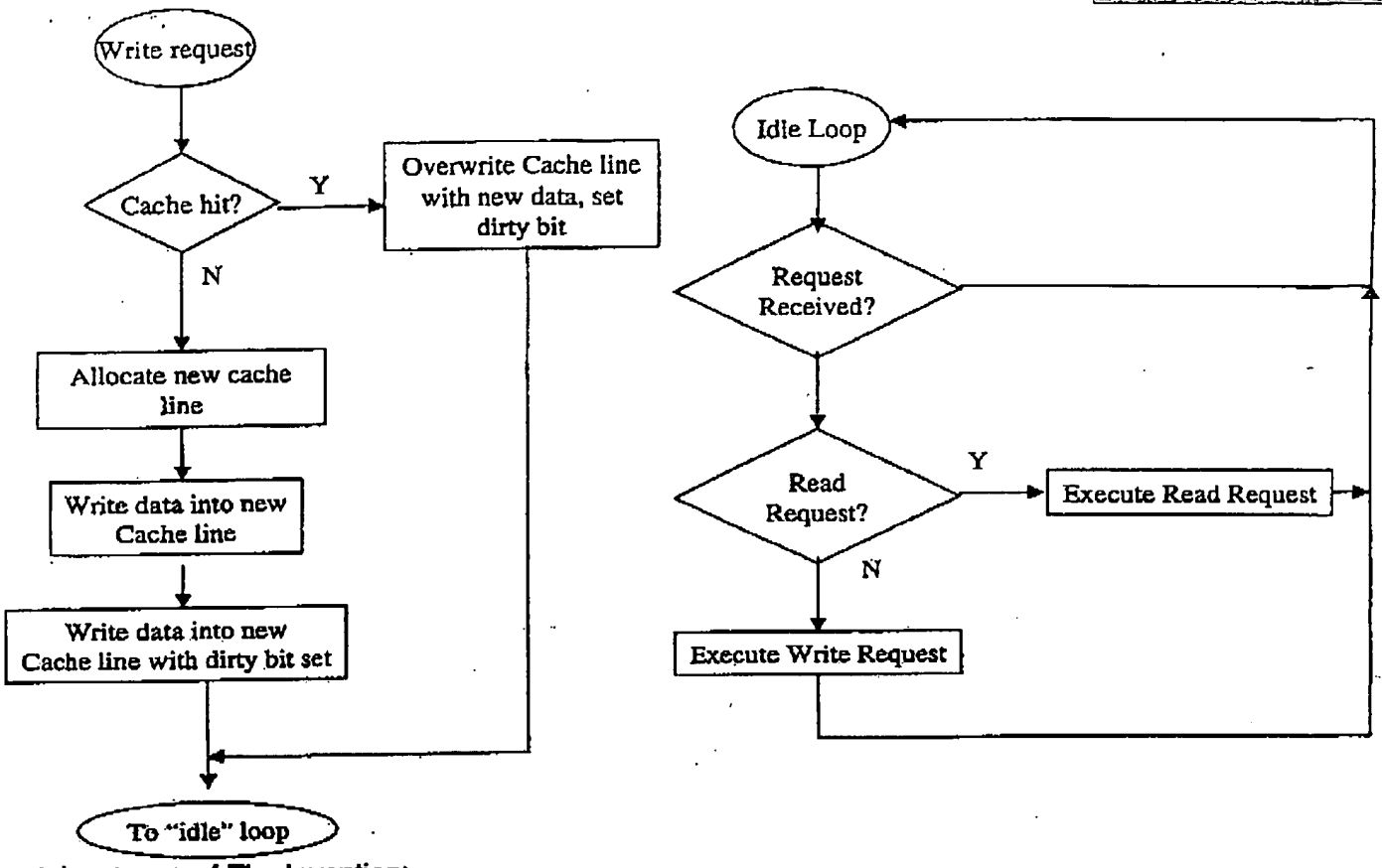
Intel, through CBD, is making/has made a series of investments in technologies and companies with technologies that have potential to be "disruptive" technologies with respect to mass storage (Boxcar, Black Butte for instance). The Boxcar investment also includes significant seed money. These technologies are aimed at the performance of mass storage and the ability of mass storage to "scale" to smaller sizes for things like basic PCs and appliances. The goal is to make the performance of mass storage in PC and Intel based appliances much better, as well as developing (or at least preserving the option of developing) a significant new business line. In addition to performance, some of the technologies have significant cost/bit advantages over existing technologies.

The leading candidate technology is ferroelectric polymer memory (PFRAM). Through an Intel Capital seed, we have a test chip in fabrication now. One of the likely uses of ferroelectric polymer memory is as a mass storage cache. However, mass storage caches have traditionally been tuned to maximize performance. The fact that PFRAM caches are non volatile and very large allows a new usage model in which the cache is tuned to deliver platform power savings as well as performance increases. The basic algorithms for power savings are the subject of this invention.

The Invention:
The disk drive is a significant power drain in mobile applications. Keeping the disk spinning consumes at least a watt of power, even with 2.5" drives. When seeking/reading/writing, the power consumption goes even higher. To mitigate this, drives are often spun down aggressively. However, this introduces significant latencies (seconds) while the disk resumes spinning. So, a significant portion of power consumption in a mobile platform is due to the disk drive, and attempts to reduce it by aggressive spin down techniques introduce significant and user visible latencies.

A mass storage cache can reduce power consumption my greatly reducing the number of instances in which the disk drive need be spun up. All that is required is some modifications to the conventional caching algorithms tuned strictly for performance. The principle modifications are firstly that writes are not written back until there is a reason to spin up the disk. This is possible because of the non-volatile nature of a mass storage cache utilizing PFRAM or similar technology. Because the cache is large, most reads can be satisfied through the cache as well. A second modification of conventional algorithms is that no prefetching is initiated if the disk drive is not spun up. Finally, conventional algorithms usually seek to detect and avoid caching sequential streams (see US4536836 and US4468730 for techniques to detect sequential streams, although in the environment at the time, sequential streams were cached) because sequential streams such as multimedia can "pollute" the cache, taking much cache space, but generating little performance value. In contrast, power saving caching algorithms attempt to aggressively prefetch sequential streams in much larger chunks that would be appropriate if performance was the only goal, so that large chunks of data are read in each time the disk drive is spun up. The large chunks, once read, are deleted from the cache, in order to free room for the next prefetch of a large chunk. In summary, the only reason to spin up the disk is a read miss. Once a read miss occurs and the disk must be spun up, then in addition to satisfying the read request, the desireable write-back operations and prefetch operations are performed before spinning down the disk. A flowchart is shown below.


Read request
Cache hit?
Y
Satisfy Request from Cache
N
Spin up disk
Allocate new cache line
Read data into new Cache line and satisfy request
Is this request part of a multimedia sequential stream?
Y
N
Deallocate cache lines dedicated to last prefetch of this stream, prefetch new cache lines
Is read prefetch desirable for non-multimedia stream case?
N
Y
Prefetch data
Look for and execute desireable write backs (algorithm not described as part of disclosure)
To "idle" loop



The Advantages of The Invention:

The advantage of this invention is that significant amounts of power can be saved in mobile/handheld products by employing these caching algorithms. This is in addition to the significant performance gains provided by the cache. A small percentage of the performance gain traded off in order to also achieve power savings.